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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/697,137

10/30/2003

Jeffrey A. West

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EXAMINER

WILCZEWSKI, MARY A

ART UNIT

PAPER NUMBER

2822

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
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3 MONTHS

03/21/2007

PAPER

**Please find below and/or attached an Office communication concerning this application or proceeding.**

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

## Office Action Summary

Application No.

10/697,137

Applicant(s)

WEST ET AL.

Examiner

M. Wilczewski

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 20 November 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-7 and 9-12 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-7 and 9-11 is/are rejected.
- 7) ☒ Claim(s) 12 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_
- ☐ Notice of Informal Patent Application
- ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Continued Examination Under 37 CFR 1.114***

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on November 20, 2006, has been entered.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-5, 7, and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chambers et al., US Patent 6,518,184, newly cited.

Chambers et al. disclose forming a dielectric layer; forming openings including vias and trenches in the dielectric layer (Figures 1 and 2); filling the openings with a barrier layer 300, a copper seed, and an electroplated copper film (Figure 3); chemically-mechanically polishing the copper film (Figure 4); after chemically-mechanically polishing the copper film, doping the copper film using silane gas without forming a copper silicide, and forming a silicon nitride layer 510 over the copper

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interconnect (Figures 5, 6, and 7 and column 6, line 59, bridging column 7 to line 10; column 9, lines 27-63; column 10, lines 2-6; column 11, line 65, bridging column 12 to line 9; and column 12, lines 37-53). Admittedly, Chambers et al. teach to dope the copper film with silicon with the RF power on.

In column 12, lines 1-9, Chambers et al. teach that the copper interconnect can be doped by either diffusion or ion implantation. In the subsequent example in lines 4-9 Chambers et al. teach to dope the copper film with silicon with the RF power on.

However, It is well known to the skilled artisan that the use of an RF-induced glow discharge can be used to excite reaction gases thereby allowing chemical reactions to occur at lower temperatures. It would have been obvious to one skilled in the art to dope the copper film with the RF power off, thereby relying solely on thermal energy to initiate and sustain the chemical reaction and cause silicon diffusion. The RF power is used in the method of Chambers et al. to transfer energy to the silane and it would have been well within the purview of one skilled in the art to recognize that the RF power in the known method of Chambers et al. could have been turned off and thermal energy solely relied upon to cause the diffusion of silicon into the copper interconnect.

Moreover, Applicant has not disclosed any criticality to performing the doping step with the RF power off. Rather, Applicant recognizes on page 8 of the specification in paragraph [0025] that ***various methods for doping the surface of copper interconnect 100 will be apparent to those of ordinary skill in the art having reference to this specification.***

Claims 6, 9, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chambers et al, US Patent 6,518,184, as applied to claims 1 and 7 above, and further in view of Zistl et al., US Patent 6,806,191, of record.

Chambers et al. is applied as above. Chambers et al. lack anticipation only of the temperature and duration of the doping step. However, Zistl et al. disclose a method of forming copper interconnects wherein the copper is doped with silicon and Zistl et al. disclose that the doping step is performed for 3-10 seconds at a temperature of 350 to 420 °C, see column 5, line 55, bridging column 6 to line 25. Due to the similarities between the processes of Chambers et al. and Zistl et al. and the teaching of Zistl et al. that the doping of a copper interconnect suppresses electromigration (abstract), it would have been obvious to one skilled in the art to implement the processing conditions of Zistl et al. in the known method of Chamber et al.

### ***Response to Arguments***

Applicant's arguments filed November 20, 2006 have been fully considered but they are not persuasive. Applicant has argued that none of the applied references teach or suggest gaseously doping the copper film with silicon without forming a copper silicide by flowing a gas chemistry consisting of silane over the copper film with the RF power off. Chambers et al. clearly teach that gaseously doping the copper film with silicon without forming a copper silicide by flowing a gas chemistry consisting of silane over the copper film with the RF power on. It would have been obvious to one skilled in

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the art to dope the copper film with silane with the RF power off, as reasoned in the above rejection.

***Allowable Subject Matter***

Claim 12 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to M. Wilczewski whose telephone number is (571) 272-1849. The examiner can normally be reached on Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Zandra Smith can be reached on 571-272-2429. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.



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